NOISE: SOUND REACTIVE FASHION

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ABSTRACT

Sound and noise have an important influence in our daily lives. They can positively or negatively change our quality of life. Given the idea that it is harder to ignore what we see, rather than what we hear, the team developed a garment that senses environmental noise and shows it through lighting, to make people aware of the noise around them. The garment chosen was a jacket, with a deliberately provocative design. It is the authors' intention to study the integration of lighting in garments for more subtle ways of expression, in other context, such as health monitoring, sports or social interaction.

Key Words: *interactive fashion, e-textiles, LED, lighting textiles, wearable technology*

1. INTRODUCTION

Sound is a physical phenomenon that follows us in our everyday lives. It can differ from very pleasant sounds to unbearable noises that cause pain to the ear, although sound is ignored very often. When is its presence felt? When silence is desired, when it is different from usual or when one can't bare it. Since sound pollution is a current environmental and health concern, it is important to call society's attention to this issue. For that to happen, the intention in this work was to create a garment in which sound and light interact dynamically. Light comes as a visual materialisation of the environmental noise, taking advantage of the idea that it is harder to ignore what we see than what we hear.

Sound is the result of air pressure changes which are detected by our ear and interpreted by the brain as music, discourse and other forms of sound. The human ear is able to detect pressure changes between 20mPa and 100mPa, which represents a difference between 0dB and 120 dB [1].

Unpleasant or undesirable sounds are called noise or sound pollution. According to Luigi Russolo [2], noise didn't really exist until the 19th century. It only came along with the advent of machinery. For centuries, life went on silently. In fact, nature is usually silent, except in some special cases, such as storms, hurricanes, waterfalls and some exceptional telluric events.

According to the World Health Organization [3], sound pollution is one of the major issues related to urban degradation and it is a matter of public health. The main agents responsible for sound pollution are transports, industrial and commercial activities or simply loud music.

Several studies have been carried out to understand the relationship between noise and human health. Results show that people may suffer psychological or physiological changes due to continuous exposure to noise [4].

Noise can be responsible for morning fatigue [5], increased anxiety [6], sleep disturbance [7], be related to the prevalence of mental disorders [8] or be a trigger of emotional responses such as anger [9].

Given that sleep is fundamental for mental recovery [10], it is suggested that subjects with a lower quality of sleep will be less capable of instantaneous reactions (reflexes) and more susceptible to mental disorders [11].

The study conducted by Babisch et al. [12] reveals that vision can be a prediction factor for noise annoyance. Pauvonić et al. [13] suggests that, during the day, the number of transports will be related to noise annoyance, while, at night, the type of transport will take this place. Given the number of different noises, it is harder to recognize the origin of each singular noise during the day. On the other hand, due to a smaller number of noise sources at night, it becomes easier to recognize its origin. This relationship suggests that the recognition of sounds may increase noise annoyance, thus vision is an important sense to predict noise annoyance. This statement confirms the premise of “it is harder to ignore what we see than what we hear”.

2. STATE OF THE ART

Garments are the skin that separates us from and connect us to the environment and, thus, a constant communicator of emotions, experiences and meanings [14]. Today, fashionable wearables (garments, accessories or jewellery that combines style and functional technology) are a mediator of information and an amplifier of fantasy [15]. According to Kirsten et al. [16], “clothing is the environment that we need and use every day”.

Several smart clothing and interactive fashion projects have been reported in the literature.

Farrington et al. [17] have developed knitted stretch sensor to measure the wearer’s movement. The project also involved the design of a jacket that incorporates the sensors and the whole electrical system. Although the project was mainly technology driven, there was the concern to design a garment that the wearer would find it pleasant to use.

The HEART-DONOR is a vest created by Laura Beloff and Erich Berger that connects people through the display of heartbeats and the presence in social networks. A sequence of up to 30 heartbeats for each of the selected friends and family are recorded. These heartbeat rhythmic patterns are then displayed in a series of small lamps, one for each person, attached to the front of the garment. Each lamp controlled by the heartbeat’s “owner” Skype account: they will change from green to red and from red to green when the person goes offline or online, respectively [18].

Profita et al. [19] present a series of Lightwear (light-emitting wearables) designed to assist the treatment of Seasonal Affective Disorder (SAD). The brown golfer’s hat is one example of the prototypes reported, which combines the looks of a classic male hat with the light therapy functionality. The attention given to emotional and social factors (i.e.: self-expression and social acceptance) is clear, since there was always the concern to create a garment that the person would want to wear, besides having its therapeutic benefits.

Yossifova and Kim [20] have designed the HearWear, an electronic skirt that, just like NOISE, reacts to environmental noise and shows it through moving light patterns. It not only addresses the issue of urban noise, but enables people to visually express their noise experiences. According to the authors, the shared experience becomes fashion.

When observing the evolution of smart clothing research, one can notice that there has been an increase in design concerns, rather than technology only. Although the first projects described were mainly technology driven, concerning only the exploration of new functionalities, the more recent projects also involve human aspects, physically, psychologically and socially.

3. MATERIALS AND METHODS

The garment designed – a male jacket - used a 100% polyester (PES) waterproof fabric as an outer shell and a 100% polyamide (PA) fabric for the lining.

A sound detector module from Sparkfun was used to measure the environmental noise. The system also includes an Arduino Nano microprocessor, and an EGLO 13532 RGB LED (light emitting diodes) strip set with infrared controller and power driver. From this set, the IR control was eliminated and wires were soldered to the power driver control inputs that were in turn connected to the Arduino PWM outputs, allowing control of LED's color and intensity. A pack of three Li-Ion rechargeable batteries (3x3,7=11,1 V) was used as the power supply. To carry the electronic system, a box was designed and printed in 3D (Figure 1).

The jacket patterns were taken from the Gerber Technology book, *Méthode de trace de vêtements masculine sportswear.* The positions for each single LED were marked in the PES fabric and holes were cut. For a better finishing, ferrules were inserted in each LED hole (Figure 2). It was used the conventional sewing method (with cotton thread) to join the parts, although ultrasound sewing would be preferable to make the garment truly waterproof.

The LED strip was cut in several spots that were then reconnected by soldering thin, isolated electric wire between them. This allowed the creation of a matrix pattern on the front and the back of the jacket. For the other electronic components, a pocket located in the back of the jacket was provided.

The system was programmed so the colors and intensity would change according to the intensity of the measured noise. A weak, slow white fade represents total silence and rapid blinking intense red shows the highest noise levels. Between these two, a continuous intensity increase, as well as a continuous color change from green to red, passing through blue, displays the measured noise level.

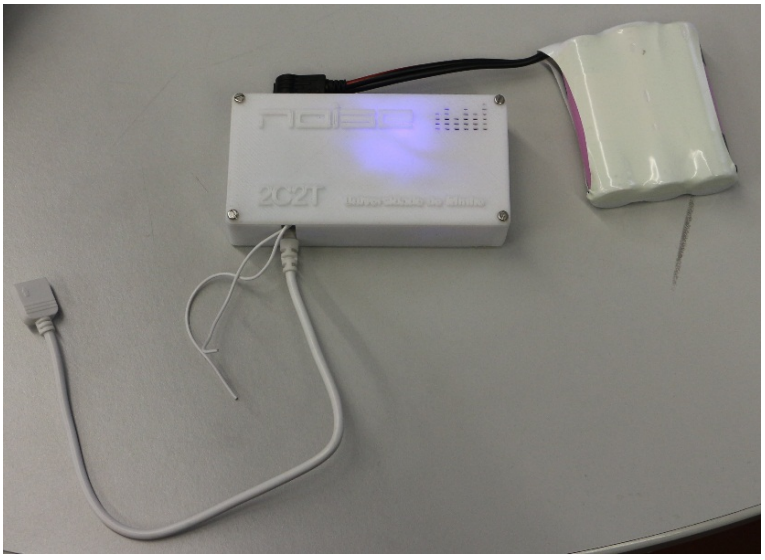

Figure 1. Electronic system inside a 3D printed box

Figure 2. Jacket's interior (Left: Overview, Right: detail of ferrules and connections)

To study how the garment would interact in different environments and how people react to this new form of fashion, a field study was conducted comprehending direct observation and video recording. Although this kind of fashion is becoming popular in some places around the globe, it is not much known in the small town of Guimarães, Portugal.

4. RESULTS AND DISCUSSION

By testing the jacket in different environments (Figures 3 to 7), one could see the colors changing the way that was expected most of the time. In silent places, the jacket kept the white color, but a vehicle passing nearby was enough to change the color of the jacket – it would go from green to red, depending on the distance between the garment and the vehicle. Inside a bar with loud music, the jacket hardly changed from red to another color. When it changed, it would stay between blue and red, so the image was purple.

Figure 3: Outside, in a silent place

Figure 4: Walking on the street

Figure 5: Near a bus, the LEDs turn to red and blink

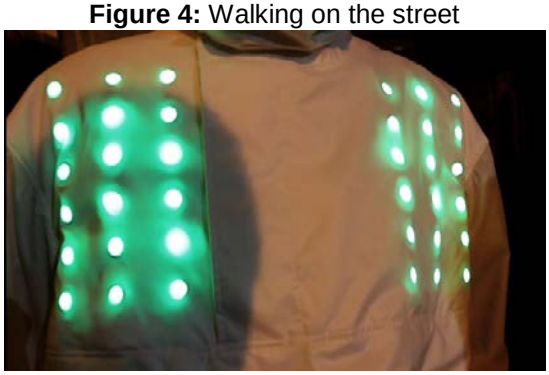

Figure 6: The LEDs turn to green when talking

Figure 7: Inside “El Rock” bar; loud music; visual effects: purple (right) and intermittent red (left)

One of the problems detected was that in order to have more accurate results, the person wearing the jacket had to be still. The sound made by the shoes when walking, for instance, was enough to produce a significant effect on the display. Another problem was the location of the system. Since the jacket wasn’t tight to the body, the system would move when the person moved, reacting to the noise of the box rubbing against the fabric, producing a false indication of environmental noise. Also, the connection between the LED strip and the control system broke after sitting and lifting up a few times, since it was located in the hip line.

The materials used in this first prototype are not suitable for a commercial application. As said before, the connection between the LED strips and the core system was broken. The changes between sitting and lifting up caused enough fatigue in the material to break. Another problem is the lack of flexibility of the materials, mainly the copper material. When bended, it stays bended until one turns it into its original form. Metal is also known for its plastic deformation. When bended, it forms cracks in the microstructure that continue to grow the more a person bends and unbends the materials, until it finally breaks. These are important aspects to take into consideration in future work.

As expected, it was possible to materialize on the visual indication of the jacket that transports and loud music are actually primary noise agents. Although it wasn’t possible to watch its reaction in a factory or nearby a building under construction, one can assume that it would react the same way, given the previous results.

It was also interesting to observe the effects that the garment had on people. Although it is not possible to state that the concept was consciously understood, no one was indifferent to the light interaction. Surprise and admiration for such a garment were stamped on people’s faces and many comments were heard, pointing to the fact that it may well be “harder to ignore what we see either what we hear”. Future work will approach a survey research to further elaborate on this statement.

5. CONCLUSIONS

Given the observations made during the experiment, it can be concluded that sight is an important factor to understand the effect of noise on people, as also discussed by other authors. People may ignore sound, but they will hardly ignore an image, especially if it’s changing.

It was also possible to analyze that people were receptive to the experience created through the Noise jacket interaction. However, it cannot truly be stated that they are culturally ready to start wearing such interactive garments.

Regarding the design process, it requires a review of the materials and construction decisions in order to optimize the garment usability and interactive behavior. This will make possible the application of similar systems in other context, such as in sports, rehabilitation, and other areas, for example as a visual indication of danger, effort or accomplishment of objectives.

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